



Development of Standards and Guidelines for the Mining Code

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Intro's and Agenda

ISA Development of Standards at Guidelines Workshop



- Jon Machin, Head of Offshore Engineering, DeepGreen since 2015
- 30 Years Experience in Major Deepwater Upstream Developments
- University of Oxford, Chartered Engineer (UK), Member of Institution of Civil Engineers



- Maersk are providing DeepGreen's vessels for exploration, survey and monitoring work in the NORI area of CCZ
- Allseas currently design/build of DeepGreen's Pilot Mining system for NORI area of CCZ
- Status :- Busy recruiting, writing standards, specifications, sub-contracts!



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Topics

- State-of-the-art standards development experience in UK
- Other case studies; EU's Blue Nodules project and experience from International Association of Oil & Gas Operators
- DeepGreen's feedback on areas where specific new work may be needed
- Some Conclusions

Standards development in UK infrastructure and energy

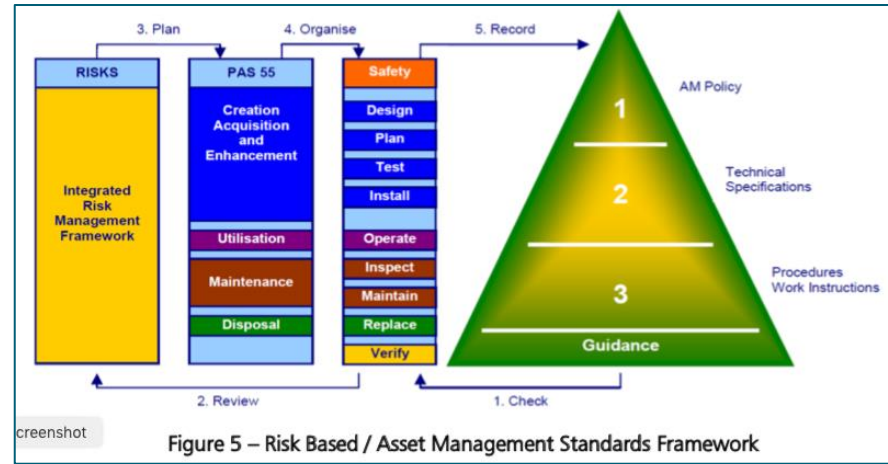
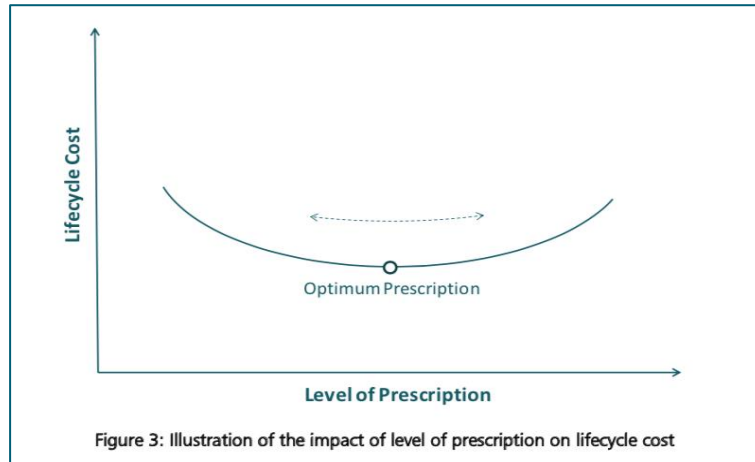
ISA Development of Standards at Guidelines Workshop

Standards - defined in UK as an agreed, fair and repeatable way of doing business safely. Published criteria designed to be used consistently as a rule, guideline or definition.

Specification is a document used by the Client to define the project requirements to a 3rd party, usually the contractor.

Since Cullen Enquiry in 1992 (after Piper Alpha oil platform disaster) standards in UK Energy sector and now much of world switched to risk based and independently regulated methods. E.g. ALARP* principle.

UK's Infrastructure Standards Group under I.C.E. currently recommends# such a process and it seems in-line with I.S.A.'s processes.



Standards development in UK infrastructure and energy

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Some engineering standards are not appropriately structured to provide clear linkages between different standards that apply to a particular asset class or a group of similar asset classes. Often different types of requirements (e.g. performance, loading, materials, etc.) are included within a single document. This makes them inflexible when applying to a wide range of projects.

It is recommended that as standards are created they should be grouped to set out the basis of design, performance standards, loading standards, design standards, material specifications and construction specifications to ensure clarity in use.

The above categorisation would allow client bodies to decide which of these standards they should retain ownership for and which ones would be best left to the trade bodies and supply chain to develop.

The client bodies should preferably retain ownership for only the “performance standards” which define the performance parameters relevant for the asset class. The performance standards should provide flexibility to adjust for individual assets/projects depending on the functional needs and potential risks.

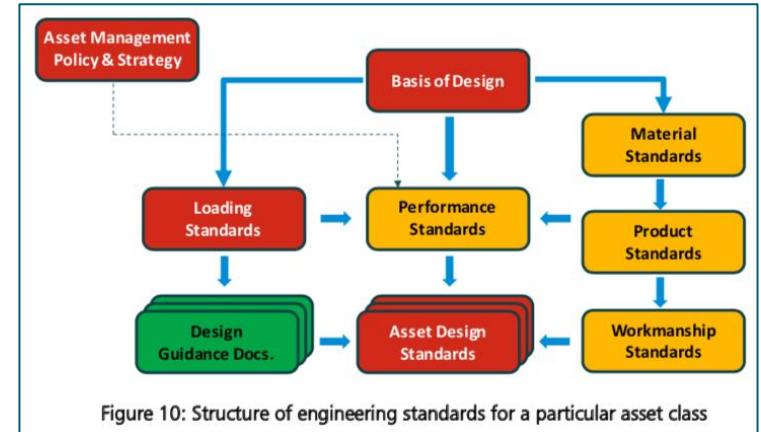


Figure 10: Structure of engineering standards for a particular asset class

Conclusion – Well crafted architecture of standards avoids reinvention of the wheel!


Some case studies:

- EU's "Blue Nodules" Joint Industry R&D project has produced a report "Rules and Regulations" listing 85 standards or guidelines relevant to Engineering components of an Offshore Mining Facility.
- IOGP* have since 2012 collaborated with ISO to reduce the myriad national, international standards converting them into a single, simple, comprehensive upstream engineering library of around 120 ISO standards.

*IOGP is International Association of Oil & Gas Producers



List of Engineering Standards Needed According to Blue Nodule EU R&D Project



OVERALL APPLICABLE INTERNATIONAL AND NATIONAL LEGISLATIONS (Ch.5):

- ISA rules, regulations and procedures (Mining Code) (Sec.5.3)
- SPONSORING STATE laws, regulations and taken administrative measures (Sec.5.4)
- FLAG STATE national laws (Sec.5.5)
- COSTAL STATE (Sec.5.6)

GENERALLY APPLICABLE STANDARDS

- Quality (Sec.8.3)
- Health and safety (Sec.8.4)
- Environmental (Sec.8.5)
- Risk assessment (Sec.8.6)
- Emergency response and procedures (Sec.8.7)
- Labor (Sec.8.8)

5 Mining Vessel

- CLASSIFICATION & CERTIFICATION (Sec.8.9.5)

- 5.21 General arrangement and stability
- 5.22 Floating unit hull
- 5.23 Machinery and marine systems
- 5.24 Electrical installations and automation
- 5.25 Safety features
- 5.26 Dynamic position system
- 5.27 Lifting appliances
- 5.28 Offshore handling systems
- 5.29 Materials and welding
- 5.01 Reception of slurry flow
- 5.02 De-watering
- 5.03 Storage
- 5.04 Treatment
- 5.05 Re-handling
- 5.06 Mining ship to 'shuttle ship' transfer
- 5.07 Power systems
- 5.08 Crew
- 5.09 Supplies
- 5.10 Maintenance facilities
- 5.11 Launch and Recovery System (LARS) facilities

2 Jumper Assembly System

- CERTIFICATION (Sec.8.9.2)

- 2.01 Jumper Hose
- 2.02 Jumper umbilical (1x)
- 2.03 Positioning and monitoring system
- 2.04 Launch and Recovery System (LARS) connection

3 Vertical Transfer System (VTS) Assembly

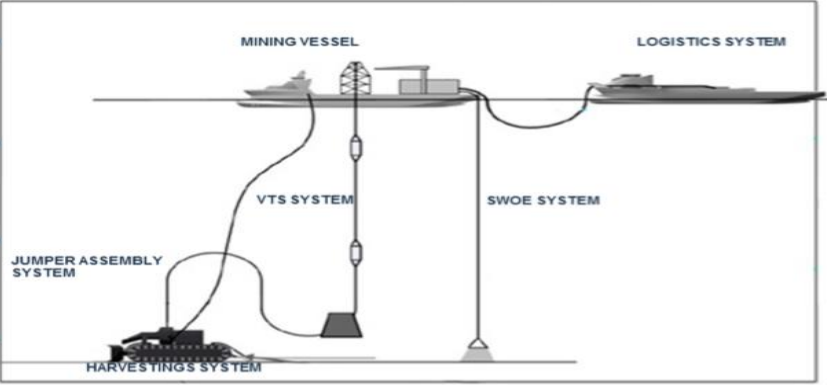
- CERTIFICATION (Sec.8.9.3)

- 3.01 Slurry (mud) riser
- 3.02 Booster station
- 3.03 Positioning and monitoring system
- 3.04 Connection to Mining Vessel
- 3.05 Connection to Jumper Assembly
- 3.06 Launch and Recovery System (LARS) connection
- 3.07 Booster station umbilical (6x)

6 Logistics System

- CLASSIFICATION & CERTIFICATION (Sec.8.10)

- 6.01 Transport shuttle vessels
- 6.02 Supply systems
- 6.03 Crew change systems
- 6.04 Harbour Equipment
- 6.05 'Shuttle ship' to 'shore' transfer



The diagram illustrates the Blue Nodule mining system. At the top, a **MINING VESSEL** and a **LOGISTICS SYSTEM** are shown on the surface. The **MINING VESSEL** is connected to a **JUMPER ASSEMBLY SYSTEM** and a **HARVESTING SYSTEM** on the seabed. A **VTS SYSTEM** (Vertical Transfer System) connects the vessel to the seabed. A **SWOE SYSTEM** (Sediment, Waste and Other Effluents Return System) is also shown. The **HARVESTING SYSTEM** is connected to the **JUMPER ASSEMBLY SYSTEM** and the **SWOE SYSTEM**.

1 Harvesting (collecting) System

- CERTIFICATION (Sec.8.9.1)

- 1.01 Propulsion system
- 1.02 Collectors (hydraulic and mechanical pick-up)
- 1.03 Sediment return
- 1.04 Subsea separation (separation of sediment from nodules)
- 1.05 Subsea comminution (cracking)
- 1.06 Slurry System
- 1.07 Mechanical systems
- 1.08 Electrical systems
- 1.09 Hydraulic systems
- 1.10 Control and Monitoring of subsea process parameters
- 1.11 Launch and Recovery System (LARS) connection
- 1.12 Harvesting vehicle umbilical (1x)

4 Sediment, Waste and Other Effluents (SWOE) Return System - CERTIFICATION (Sec.8.9.4)

- 4.01 Pipe
- 4.02 Chute
- 4.03 Connection to vessel
- 4.04 Launch and Recovery System (LARS) connection
- 4.05 Positioning and monitoring system

ISO Standards for use in the oil & gas industry

<p>ISO 10418 Process safety systems (Rev)</p> <p>ISO 10419 Replaced by API Spec 4Q/2</p> <p>ISO 10423 Wellhead & Christmas tree equipment</p> <p>ISO 10489 Reliability modelling safety systems</p> <p>ISO 10534 Shallow gas diverter equipment</p> <p>ISO 10535 Driftthrough equipment (ISO/PI)</p> <p>ISO 10534 Hoisting equipment – maintenance</p> <p>ISO 10538 Hoisting equipment – specification</p> <p>ISO 10526 Drilling and well-servicing structures</p> <p>ISO 10702 Control and mitigation of fires and explosions</p> <p>ISO 10703 Offshore piping systems</p> <p>ISO 10224 Reliability and maintenance data (Rev)</p> <p>ISO 10497 GPR piping, Parts 1-4 (Rev)</p> <p>ISO 10493 Drilling equipment</p>	<p>ISO 15139 Heating, ventilation and air-conditioning (Rev)</p> <p>ISO 15136 Cracking-resistant materials for use in H₂ environments, Parts 1-3</p> <p>ISO 15544 Emergency response</p> <p>ISO 15463 Life cycle costing, Parts 1-3</p> <p>ISO 16001 Risk assessment in the design of offshore LNG installations</p> <p>ISO 16063 Characteristics of LNG filling design and material selection</p> <p>ISO 16094 LNG Marine Transfer Arms (New)</p> <p>ISO 17774 Unconventional LNG transfer systems</p> <p>ISO 17922 Metal ball valves</p> <p>ISO 17776 Major Accident hazard management during design (Rev)</p> <p>ISO 17921 Duplex stainless steel materials testing requirements (New)</p> <p>ISO 17782 Qualification of manufacturers of special materials (New)</p> <p>ISO 17945 Materials resistant to sulfide stress cracking</p> <p>ISO 17949 Guidelines on compliance for sponsored (Rev)</p> <p>ISO 18483 Systems and installations for supply of LNG as fuel to ships</p> <p>ISO 10388 Standard Cost Coding System (Rev)</p> <p>ISO 20815 Production assurance and reliability management</p> <p>ISO 21457 Materials selection</p> <p>ISO 20934-1 Thermoplastic</p> <p>ISO 20934-2 Elastomers</p> <p>ISO 27469 Method of test for offshore fire dampers</p> <p>ISO 20601 Sector-specific quality management systems</p>	<p>ISO 10285 Offshore containers, Part 1-3 (New)</p> <p>ISO 18647 Modular drilling rigs for offshore fixed platforms (New)</p> <p>ISO 18717-1 Elastomers; coating of offshore structures (New)</p> <p>ISO 19900 General requirements for offshore structures</p> <p>ISO 19914-1 Meccanic design and operating considerations</p> <p>ISO 19914-2 Seismic design procedures and criteria (Rev)</p> <p>ISO 19914-3 Topsides structure</p> <p>ISO 19914-4 Geotechnical and foundation design (Rev)</p> <p>ISO 19914-5 Weight control (Rev)</p> <p>ISO 19914-6 Marine operations</p> <p>ISO 19914-8 Marine risk investigations</p> <p>ISO 19902 Fixed steel offshore structures</p> <p>ISO 19914-10 Fixed concrete offshore structures (Rev)</p> <p>ISO 19914-11 Monoliths, semi-cylindrical and spars (Rev)</p> <p>ISO 19914-12 Site-specific assessment of jack-ups (Rev)</p> <p>ISO 19914-20 Jack-ups commentary</p> <p>ISO 19914-21 Site-specific assessment of floating units (New)</p> <p>ISO 19916 Arctic offshore structures</p> <p>ISO 30101 Arctic Operations – Working environment (New)</p> <p>ISO 30103 Arctic Operations – Environmental monitoring (New)</p> <p>ISO 30104 Arctic operations – Risk management (New)</p> <p>ISO 30105 Arctic meteorology, ice and seabed data (New)</p>	<p>ISO 29775-5 Encumbrance – procurement</p> <p>ISO 10428 Sucker rods</p> <p>ISO 10421 Pumping units</p> <p>ISO 10426 Bottom-hole steel gate valves</p> <p>ISO 10426 Replaced by API Spec 611</p> <p>ISO 10427 Special-purpose steam turbines</p> <p>ISO 10428 Lubrication, shaft-walsh and control-hill systems, Parts 1-4</p> <p>ISO 10429 Centrifugal compressors</p> <p>ISO 10441-1 Rotating positive-displacement process compressors (subfield)</p> <p>ISO 10442-2 Rotary PD packaged air compressors</p> <p>ISO 10441 Flexible couplings – special</p> <p>ISO 10442 Energy-rated air compressors</p> <p>ISO 12121 Spiral plate heat exchangers</p> <p>ISO 12122 Helix heat exchangers</p> <p>ISO 13631 Reciprocating gas compressors</p> <p>ISO 13691 High speed enclosed gear units</p> <p>ISO 13704 Calculation of heater tube thickness</p> <p>ISO 13705 Fired heaters for general service</p> <p>ISO 13706 Air-cooled heat exchangers</p> <p>ISO 13707 Reciprocating compressors</p> <p>ISO 13709 Centrifugal pumps</p> <p>ISO 13710 Reciprocating positive displacement pumps</p> <p>ISO 14691 Flexible couplings – general</p> <p>ISO 15647 Heat exchangers, Parts 1-2</p> <p>ISO 15649 Piping</p>	<p>ISO 15761 Steel valves DN 100 and smaller</p> <p>ISO 16812 Shell & tube heat exchangers</p> <p>ISO 16901 Risk assessment of onshore LNG installations</p> <p>ISO 16904 Internal coating and lining of steel storage tanks</p> <p>ISO 17177 Unconventional LNG transfer systems</p> <p>ISO 17292 Metal ball valves</p> <p>ISO 17348 Materials Selection in CO₂ Environment for casing, tubing and downhole equipments (New)</p> <p>ISO 17349 Streams containing high levels of CO₂ (New)</p> <p>ISO 18764-1 Internal coating and lining of process vessels (New)</p> <p>ISO 18824-1 Design and testing of LNG storage tanks</p> <p>ISO 20084-1 Resistance to organic spillage of insulation materials = Liquid phase (New)</p> <p>ISO 20084-2 Centrifugal and rotary pumps shaft sealing</p> <p>ISO 20209 Replaced by API Std 521</p> <p>ISO 20217 Composite repairs for pipelines (Rev)</p> <p>ISO 20457 Flare details</p> <p>ISO 20759 Compact flanged connections</p> <p>ISO 20800 Venting of storage tanks</p> <p>ISO 28440 LNG – Ship to shore interface</p>
<p>ISO 13628-1 Subsea production systems</p> <p>ISO 13628-2 Subsea flexible pipe systems</p> <p>ISO 13628-3 Subsea TFL pumpdown systems</p> <p>ISO 13628-4 Subsea wellhead and tree equipment</p> <p>ISO 13628-5 Subsea control umbilicals</p> <p>ISO 13628-6 Subsea production controls</p> <p>ISO 13628-7 Completion/workover riser system</p>	<p>ISO 13628-8 ROT and interlocks</p> <p>ISO 13628-9 ROT intervention systems</p> <p>ISO 13628-10 Bonded flexible pipe</p> <p>ISO 13628-11 Flexible pipe systems for subsea and marine applications</p> <p>ISO 13628-15 Subsea structures and manifolds</p>	<p>ISO 11949 Casing and tubing for wells</p> <p>ISO 11941 Drill pipe</p> <p>ISO 12885 Qualification of casing connections for thermal wells</p> <p>ISO 13085 Tubing aluminum alloy pipes</p> <p>ISO 13090 Drilling fluids</p> <p>ISO 13091 Drilling fluids – processing systems evaluation</p> <p>ISO 13092 Measurement of viscous properties of completion fluids</p> <p>ISO 13093-2 Measurement of properties of proppants</p> <p>ISO 13093-3 Testing of heavy brines</p> <p>ISO 13094 Measurement of saturation & gravimetric fluid leakage</p> <p>ISO 13093-5 Measurement of long term conductivity of proppants</p> <p>ISO 13093-6 Measuring leak-off of completion fluids under dynamic conditions</p> <p>ISO 13078 Thread compounds</p> <p>ISO 13079 Casing and tubing connections testing</p> <p>ISO 13480 CFA seamless tubes for casing & tubing</p> <p>ISO 14310 Pickers and bridge plugs</p>	<p>ISO 14998 Accessory completion equipment</p> <p>ISO 15136 Progressing cavity pump systems, Parts 1-2</p> <p>ISO 15483 Field inspection of new casing, tubing and plan end drill pipe</p> <p>ISO 15444 Gauging and inspection of threads</p> <p>ISO 15831-1 Electric submersible pump systems for artificial lift</p> <p>ISO 15846 Aluminum alloy drill pipe</p> <p>ISO 16070 Lock mandrels and related equipment</p> <p>ISO 15934-1 Well integrity life cycle governance manual (New)</p> <p>ISO 15934-2 Well integrity operational phase</p> <p>ISO 17076-1 Strip-lead mandrels</p> <p>ISO 17076-2 Flow control devices for side-pocket mandrels</p> <p>ISO 17076-3 Latches & seals for side-pocket mandrels & flow control devices</p> <p>ISO 17076-4 Strip-lead mandrels and related equipment</p> <p>ISO 17824 Sand control screens</p> <p>ISO 20012 Design of aluminum drill collar</p> <p>ISO 20747 Aluminum alloy drill pipe thread gauging</p> <p>ISO 20781 Subsurface tubing mounted formation barriers</p>	<p>ISO 16440 Steel cased pipelines (New)</p> <p>ISO 16788 Pipeline reliability-based limit state design</p> <p>ISO 19054-1 Life cycle energy management for offshore pipeline</p> <p>ISO 21329 Test procedures for pipeline mechanical connectors</p> <p>ISO 21807-1 Polyethylene coatings (2-Layer PE and 2-Layer PP)</p> <p>ISO 21807-2 Fusion-bonded epoxy coatings</p> <p>ISO 21807-3 Field line coatings (Rev)</p> <p>ISO 21807-4 Polyethylene coatings (2-Layer PE)</p> <p>ISO 21807-5 External concrete coating (Rev)</p>
<p>ISO 10400 Calculations for OCTG performance properties</p> <p>ISO 10405 Carve-out of casing tubing</p> <p>ISO 10407-1 Drill stem design</p> <p>ISO 10407-2 Inspection and classification of drill stem elements</p> <p>ISO 10414-1 Field testing of water-based fluids</p> <p>ISO 10414-2 Field testing of oil-based drilling fluids</p> <p>ISO 10414-3 Drilling fluids – air testing</p> <p>ISO 10417 Subsurface safety valve elements</p> <p>ISO 10422 Replaced by API Spec 50</p> <p>ISO 10424-1 Rotary drill stem elements</p> <p>ISO 10424-2 Threading and gauging of connectors</p>	<p>ISO 10424-1 Well cementing</p> <p>ISO 10424-2 Testing of well cements</p> <p>ISO 10424-3 Testing of deepwater well cement</p> <p>ISO 10424-4 Atmospheric trapped cement slurries</p> <p>ISO 10424-5 Shrinkage and expansion of well cement</p> <p>ISO 10424-6 Static and dynamic strength of cement formulations</p> <p>ISO 10427-1 Blow-spring casing centralizers</p> <p>ISO 10427-2 Centralizer placement and slip-collar testing</p> <p>ISO 10427-3 Performance testing of cement float equipment</p> <p>ISO 10432 Subsurface safety valves</p> <p>ISO 10433 Replaced by API Spec 50/1</p>	<p>ISO 11949 Casing and tubing for wells</p> <p>ISO 11941 Drill pipe</p> <p>ISO 12885 Qualification of casing connections for thermal wells</p> <p>ISO 13085 Tubing aluminum alloy pipes</p> <p>ISO 13090 Drilling fluids</p> <p>ISO 13091 Drilling fluids – processing systems evaluation</p> <p>ISO 13092 Measurement of viscous properties of completion fluids</p> <p>ISO 13093-2 Measurement of properties of proppants</p> <p>ISO 13093-3 Testing of heavy brines</p> <p>ISO 13094 Measurement of saturation & gravimetric fluid leakage</p> <p>ISO 13093-5 Measurement of long term conductivity of proppants</p> <p>ISO 13093-6 Measuring leak-off of completion fluids under dynamic conditions</p> <p>ISO 13078 Thread compounds</p> <p>ISO 13079 Casing and tubing connections testing</p> <p>ISO 13480 CFA seamless tubes for casing & tubing</p> <p>ISO 14310 Pickers and bridge plugs</p>	<p>ISO 14998 Accessory completion equipment</p> <p>ISO 15136 Progressing cavity pump systems, Parts 1-2</p> <p>ISO 15483 Field inspection of new casing, tubing and plan end drill pipe</p> <p>ISO 15444 Gauging and inspection of threads</p> <p>ISO 15831-1 Electric submersible pump systems for artificial lift</p> <p>ISO 15846 Aluminum alloy drill pipe</p> <p>ISO 16070 Lock mandrels and related equipment</p> <p>ISO 15934-1 Well integrity life cycle governance manual (New)</p> <p>ISO 15934-2 Well integrity operational phase</p> <p>ISO 17076-1 Strip-lead mandrels</p> <p>ISO 17076-2 Flow control devices for side-pocket mandrels</p> <p>ISO 17076-3 Latches & seals for side-pocket mandrels & flow control devices</p> <p>ISO 17076-4 Strip-lead mandrels and related equipment</p> <p>ISO 17824 Sand control screens</p> <p>ISO 20012 Design of aluminum drill collar</p> <p>ISO 20747 Aluminum alloy drill pipe thread gauging</p> <p>ISO 20781 Subsurface tubing mounted formation barriers</p>	<p>ISO 16440 Steel cased pipelines (New)</p> <p>ISO 16788 Pipeline reliability-based limit state design</p> <p>ISO 19054-1 Life cycle energy management for offshore pipeline</p> <p>ISO 21329 Test procedures for pipeline mechanical connectors</p> <p>ISO 21807-1 Polyethylene coatings (2-Layer PE and 2-Layer PP)</p> <p>ISO 21807-2 Fusion-bonded epoxy coatings</p> <p>ISO 21807-3 Field line coatings (Rev)</p> <p>ISO 21807-4 Polyethylene coatings (2-Layer PE)</p> <p>ISO 21807-5 External concrete coating (Rev)</p>



Standards in purple issued in 2016
Standards in blue are a priority for 2017 issue

These ISO standards, TR and TS (abbreviated titles) are only a core collection of several hundreds of standards available for the oil & gas industry from ANSI, ANSI, API, AS, BSI, CSA, NORSOK, NF, GOST, SAE, etc. Some ISO/TC47 standards have been withdrawn and the relevant API standard is referenced above



LINK: <https://www.iogp.org/bookstore/product/iso-standards/>

Some Specific New Engineering Guidance from ISA may be Needed.....

No.	Need for a Standard	Requirement
1	Structural safety, reliability and fatigue. Covers floating and subsea facilities, seabed integrity.	<i>Ensure structural integrity and safety. Considers probability of structural failures. Factors of Safety (FoS) in design can vary widely. Probably covered by existing ISO standards in loads and materials subject to clarification or consensus of FoS requirements, but specific ISA guidance may be appropriate particularly on seabed stability and geo-hazards.</i>
2	Subsea shut down requirements. Both planned and emergency scenarios.	<i>Time to shut down, how is it triggered. What subsea equipment is left on seabed, does it have to be recovered. E.g. foundation pilings may be need to installed for hurricane standby anchors.</i>
3	Subsea intervention interfaces	<i>Does regulator require common intervention interfaces for safety to allow different contractors on adjacent licences to rescue each others subsea equipment in an emergency. Cost involved. If required, oilfield ISO standards can cover already.</i>
4	New technology/component qualification	<i>How should this be defined? Joint Industry Collaboration? What level of testing? TRL system now adopted by multiple industries.</i>
5	Data handling storage and distribution protocols	<i>File formats, compatibility, security, confidentiality</i>

Conclusions

- ISA's development process for Standards sounds like its inline with state-of-the-art from other asset management sectors.
- Upstream offshore energy sector definitely provides a comprehensive and highly applicable library of engineering standards available for use.
- Existing documents should be read, reviewed, edited (if necessary) and adopted. Not simply cut and paste!
- Joint Industry Projects for new technology subjects, with their standards development committees, has proved a successful process in upstream offshore energy.
- Contractors, and all stake-holders, must have important voice throughout this process!